

## **STOTLER VARIABLE DISPLACEMENT RADIAL ROTARY PISTON ENGINE**

### **BACKGROUND OF THE INVENTION**

This design has been developed from the Stotler Radial Rotary Piston Engine patent application number 10/245,968 to provide variable engine displacement and variable compression ratio. This patent details the use of a cam to drive the pistons instead of crankshafts as presented in the seventh claim of the aforementioned patent application. The use of a cam to actuate the pistons instead of crankshafts provides several advantages. The piston position is controlled by the shape of the cam and not the circular motion of a crankshaft. The cam profile can position the piston anywhere with regards to the rotational position of the hub. A simple articulation of the cam mechanism results in varying the engine displacement by changing the length of the strokes. The dimensions of the combustion chamber can be left constant so this also has the effect of varying the compression ratio of the engine. The result is an engine that can be very fuel-efficient and clean burning during partial throttle but provide very high power output when desired.

## SUMMARY OF THE INVENTION

The present invention comprises an internal combustion engine with at least one piston and a hub that acts as a rotary valve. Multiple pistons, six in this example, are arranged radially around the central hub and compress inward toward the hub. The hub acts as a single rotary valve that services all the pistons around it. The rotary valve hub includes passageways to provide for fuel/air intake, exhaust, and coolant as well as an ignition devise. The pistons are actuated by a cam that is affixed to the hub. As the hub rotates once in relation to the piston cylinder it opens to provide a fuel air mixture during the intake stroke of the piston, seals the cylinder for the compression stroke, ignites combustion, remains sealed for the power stroke and opens the cylinder to allow gasses to escape during the exhaust stroke. The use of a cam to actuate the pistons in this radial design allows the four piston strokes to vary in length. For instance, the compression stroke can be shorter or longer than the combustion stroke. In addition the top dead center combustion chamber volume can differ from the top dead center chamber volume between valve actuation. In fact the term top dead center no longer need apply to this system as the piston position is controlled by the shape of the cam and not the circular motion of a crankshaft. Changing the cam profile during operation can be done if the cam is split into two halves. A simple articulation of the cam halves results in varying the engine displacement. This also has the effect of varying the compression ratio of the engine.

## BRIEF DESCRIPTIONS OF THE DRAWINGS

The accompanying drawings illustrate the invention and in such drawings:

**FIG. 1** is a view of the engine of the present invention.

**FIG. 2** is a side view of the engine.

**FIG. 3** is a perpendicular cross sectional view of **FIG. 2** through broken line A.

**FIG. 4** is similar to **FIG. 2** except some of the outer housing has been removed.

**FIG. 5** is a perpendicular cross sectional view of **FIG. 4** through broken line A.

**FIG. 6** is similar to **FIG. 4** except that the hub assembly has been rotated.

**FIG. 7** is a perpendicular cross sectional view of **FIG. 6** through broken line A.

**FIG. 8** is a view of the hub and cam assembly.

**FIG. 9** shows the other side of the hub and cam assembly.

**FIG. 10** is a view from the front of the engine.

**FIG. 11** is a perpendicular cross sectional view of **FIG. 10** through broken line B.

## DETAILED DESCRIPTION OF THE INVENTION

**FIG. 1** is a view of the engine of the present invention with six cylinders. This view shows the appearance of the engine from the outside. Notation **1** is the passageway where the air-fuel mixture enters the engine. The rest of the induction system is not depicted and is not included in this patent. Notation **2** is the passageway where the exhaust exits the engine. The rest of the exhaust system and drive train is not depicted and is not included in this patent.

**FIG. 2** is a side view of the engine. Item **3** is the front structure of the engine. The primary function of this structure is to mount the front main bearing of the engine. It also provides a mounting point for the intake manifold, alternator, water pump, and other accessories (all not shown). Item **4** is a fan belt groove and is part of the hub assembly that rotates in conjunction with the hub. These two grooves are provided to drive any accessories as needed. Item **5** is a timing wheel that is used for the ignition system (not shown). Item **6** is a passageway that allows air to cool the hub. As the hub spins, centrifugal action draws air through the engine and out these openings much like a vented disk brake. Item **7** is the outer housing of the engine and also functions to hold the engine oil. Item **8** is the exhaust passageway. Item **9** provides a mount for the rear main bearing as well as the clutch and transmission (not shown). Item **10** is the crank shaft. The flywheel (not shown) would mount to this. Item **11** is the exhaust manifold.

**FIG. 3** is a perpendicular cross sectional view of **FIG. 2** through broken line **A** and perpendicular to the axis of rotation. Item **12** is the outer housing (same as Item **7**). Item **13** is the outer bearing attached to the piston. This consists of a wheel mounted on a high-speed ball bearing. Item **14** is the inner bearing attached to the piston. This consists of a wheel mounted on two high-speed ball bearings. The inner bearings will be subjected to the far greater forces of combustion so they are made larger and stronger. Item **15** is the cam which rotates in conjunction to the hub assembly. The inner and outer piston bearings ride on the cam. As the cam/hub assembly rotates, the bearings transmit linear motion to the pistons and vice versa. This cam is divided into two halves and is shown here in the expanded position. The articulation of these two cam halves allows for the variable displacement of this engine. Item **16** is the engine block. Item **17** is a cylinder seal that is spring loaded against the hub. This acts similar to a head gasket and rides against the hub and floats concentric to the cylinder liner. The tightness of this seal is determined by the strengths of the springs and the compression ratio. Compression in the cylinder acts to tighten this seal. Item **18** is the piston. Item **19** is the spark plug. This is mounted within the hub assembly. The spark plug is seen here positioned to allow for a large timing advance. If more spark energy or a greater range of spark advance is desired additional spark plugs or glow plugs can be added. Item **20** is one of many cooling fins in the hub. Air pulled through these fins act to cool the hub. Notation **21** shows the cylinder chamber during the combustion stroke. Notation **22** shows a coolant passageway through the engine block. Notation **23** shows the exhaust passageway through the hub. Notation **24** shows the intake passageway through the hub.

**FIG. 4** is a view similar to **FIG. 2** except some of the outer housing has been removed to reveal some of the inner components. Item **25** is the front main bearing of the hub. Item **26** is a bolt to hold together the outer housings. Item **27** is an exhaust manifold bolt. Item **28** is a transmission mount bolt. Item **29** is the rear main bearing for the hub assembly. Item **30** is one of the coolant passageways for the block. The second coolant passageway is located directly behind item **30** in this view. Item **31** is a component that maintains the alignment of the piston within the cylinder.

**FIG. 5** is a perpendicular cross sectional view of **FIG. 4** through broken line **A** and perpendicular to the axis of rotation. **FIG. 5** shows the cam in the position that results in the engine's minimum displacement where as **FIG. 3** shows the cam expanded in the position of maximum engine displacement. Notation **32** shows the cylinder chamber at the end of the intake stroke. Notation **33** shows where the two halves of the cam contact each other when the engine is at minimum displacement. Item **34** is part of the hub assembly that has been revealed from the movement of the cam half inward. Notation **36** shows the cylinder chamber at the end of the combustion stroke. When compared to **FIG. 3** the stroke of the pistons of notations **32** and **35** has been reduced by the same amount as the displacement seen at **34**. The articulation of the cam halves does not alter the piston top dead center position at notation **33**. The height of the combustion chamber is always constant. Increasing the engine displacement while maintaining the same combustions chamber dimensions has the effect of increasing the compression ratio. The use of a cam to move the pistons allows the lengths of the intake stroke and combustion stroke to be different. This can be seen by comparing the piston positions at notations **32** and **35**. Notation **36** shows one of the air passageways through the center of the hub.

**FIG. 6** is similar to **FIG. 4** except that the hub assembly has been rotated relative to the block. Item **37** is one of cam bolts and can now be seen.

**FIG. 7** is a perpendicular cross sectional view of **FIG. 6** through broken line **A** and perpendicular to the axis of rotation. Notation **38** is the cylinder chamber during the compression stroke. Notation **39** is the cylinder chamber at top dead center and the beginning of the combustion stroke. Notation **40** is the cylinder chamber during the combustion stroke. Notation **41** is the cylinder chamber during the exhaust stroke with the cylinder opened to the exhaust passageway of the hub. Item **42** is the piston in the top dead center position. The cam profile allows the top dead center piston position to be different at Item **42** to that at notation **39** (the combustion position). The exhaust stroke can be set to empty the cylinder to near zero volume without any valve overlap. The flexibility of the cam to position the piston in any desired position relative the hub allows this design to offer many tuning options. In addition to independently setting stroke lengths the acceleration of the piston between end points can be set. The pistons can also be held at the end of the stroke for a period of time if desired.

**FIG. 8** is a view of the hub and cam assembly. The bolts holding the cam halves together have been extracted and revealed. Item **43** is one of four bolts used to mount springs within the cam assembly. These four springs (item **44**) act to hold the cam halves (item **45**) together in the minimum displacement position. During engine operation three other forces will also be acting on the cam halves. Centrifugal forces will act to expand the cam halves as the rpm of the engine increases. So after the rpm reaches a certain value, the cam halves will be held in the maximum displacement position. The forces within the cylinders will also act to expand or close the cam halves corresponding to

throttle position. With the throttle closed, the engine vacuum created in the intake cylinder will act to close the two cam halves together. As the throttle is opened, the reduction in vacuum in the intake cylinders and the increase in combustion pressures in the expansion cylinders will act to separate the cam halves and increase the engine displacement. The strength of the cam springs will determine how the engine displacement will respond to rpm and throttle inputs.

Item **46** connects the hub assembly with the two cam halves. Item **47** is the hub with many of its passageways in view. Item **48** is one of two gears that make the cam halves expand symmetrically and helps to keep them in alignment. Linking these two gears with another gear in the location of Item **46** (but not shown) would ensure that the two cam halves would expand symmetrically. Item **49** is a bolt in connection with item **46**.

Notation **50** shows how the cam halves are intermeshed at the point of cam half separation. The cam surface interlocks here to provide a smooth surface for the piston bearings to ride upon during cam articulation. The length of these interlocking fingers determines how much displacement can be added to the engine. Item **51** is a non-spring loaded bolt. Its function is to limit the expansion of the cam halves and maintain their alignment. Notation **53** shows the cam surface where the inner piston bearings ride.

Notation **54** shows the cam surface where the outer piston bearings ride.

Notation **52** shows the passageway where air enters the hub assembly to cool it.

Notation **55** shows the hub passageway where exhaust gasses leave the pistons. Notation **56** shows the passageway where exhaust gasses leave the hub assembly to enter the exhaust manifold. Notation **57** shows the fuel-air passageway through the hub where it would then enter into the cylinders.

**FIG. 9** shows the other side of the hub and cam assembly. Item **59** is one of the main bolts connecting to the cam assembly (same as item **49**). It is solidly bolted to the hub assembly. The other smaller bolts similar to item **58** are bolted directly to the cam halves but mount in grooves in the hub assembly. They move to allow the articulation of the cam while still transferring engine torque to the hub assembly.

**FIG. 10** is a view from the front of the engine.

**FIG. 11** is a perpendicular cross sectional view of **FIG. 10** through broken line **B** and parallel to the axis of rotation. Notation **60** shows one of the coolant passageways through the block. These coolant passageways are arranged in a polygon to provide even cooling of the block and connect to the crossing passageways as depicted by notation **22**. Connected, these passageways are fed by one entry and one exit point to the engine at notation **30**.

To match various applications, the engine of the type of the present invention may be made with multiple rings with any number of radially aligned pistons therefore providing for an unlimited number of pistons and configurations.

Several embodiments of the present invention have been described in detail; however, various modifications may be made without departing from the scope and spirit of the invention. Accordingly the present invention is not to be limited, and is based upon the following claims.